Taxonomic status of Scaled Ground Cuckoo *Neomorphus squamiger* Todd, 1925

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Summary.—Scaled Ground Cuckoo *Neomorphus squamiger* Todd, 1925, is a rare and poorly known taxon from Pará and Amazonas, Brazil. Most taxonomic authorities have treated it as a subspecies of Rufous-vented Ground Cuckoo *N. geoffroyi* owing to plumage similarities and distribution. The aim of this study was to review the taxonomic status of *N. squamiger* in the light of a new specimen from the east bank of the rio Xingu, representing a significant eastward range extension. Examination of the 17 known specimens of *N. squamiger* revealed that the diagnostic characters are relatively invariable across its restricted geographic range in the Madeira–Tapajós–Xingu–Tocantins interfluvia. The rio Xingu specimen exhibits no signs of intergradation with the nearest population of *N. geoffroyi,* east of the rio Tocantins. The absence of intergradation and the previously reported difference in mitochondrial DNA between *N. squamiger* and *N. geoffroyi* suggest that *N. squamiger* should be treated as a species.

Neotropical ground cuckoos of the genus *Neomorphus* Gloger, 1827, are rare terrestrial birds that inhabit humid forests (to 1,000 m above sea level) from Nicaragua to south-east Brazil (Haffer 1977, Meyer de Schauensee 1982). The genus comprises four or five species depending on taxonomy (Haffer 1977, Payne 1997, 2005, Dickinson 2003), differing in plumage pattern and colour, and coloration of the bill and orbital skin. Red-billed Ground Cuckoo *N. pucheranii* (Deville, 1851) and Rufous-vented Ground Cuckoo *N. geoffroyi* (Temminck, 1820), are polyphyletic (Haffer 1977, Payne 1997, 2005), and some of the named subspecies may warrant elevation to species status (Raposo *et al.* 2009). Two other species, Banded Ground Cuckoo *N. radiolosus* Sclater & Salvin, 1878, and Rufous-winged Ground Cuckoo *N. rufipennis* (G. R. Gray, 1849), are considered monotypic. The fifth species, Scaled Ground Cuckoo *Neomorphus squamiger* Todd, 1925, was described from a male (Fig. 1)

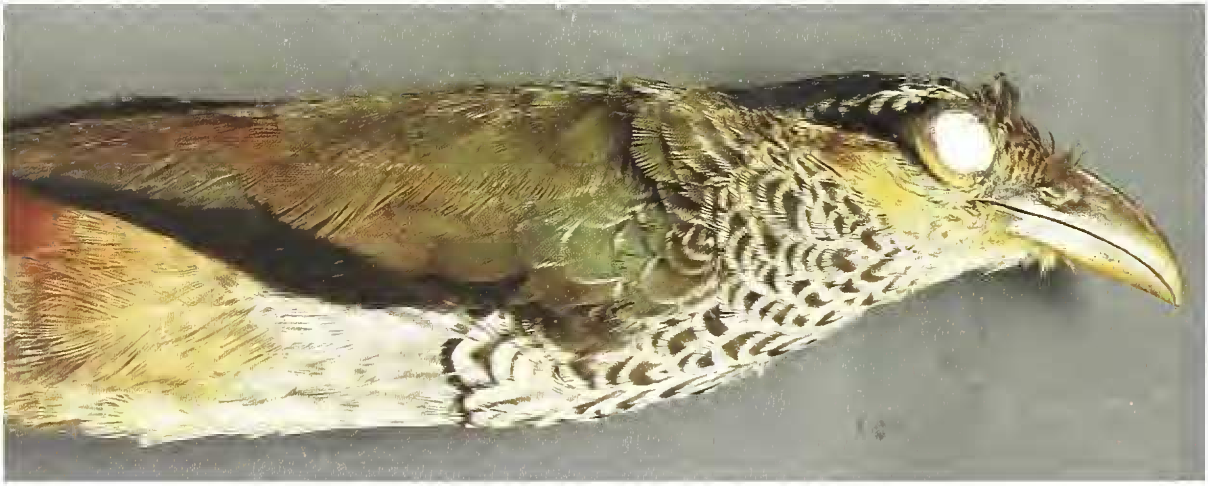

Figure 1. Lateral view of the type specimen of *Neomorphus squamiger* Todd, 1925 (CMNH 74615) (Marcos A. Raposo)

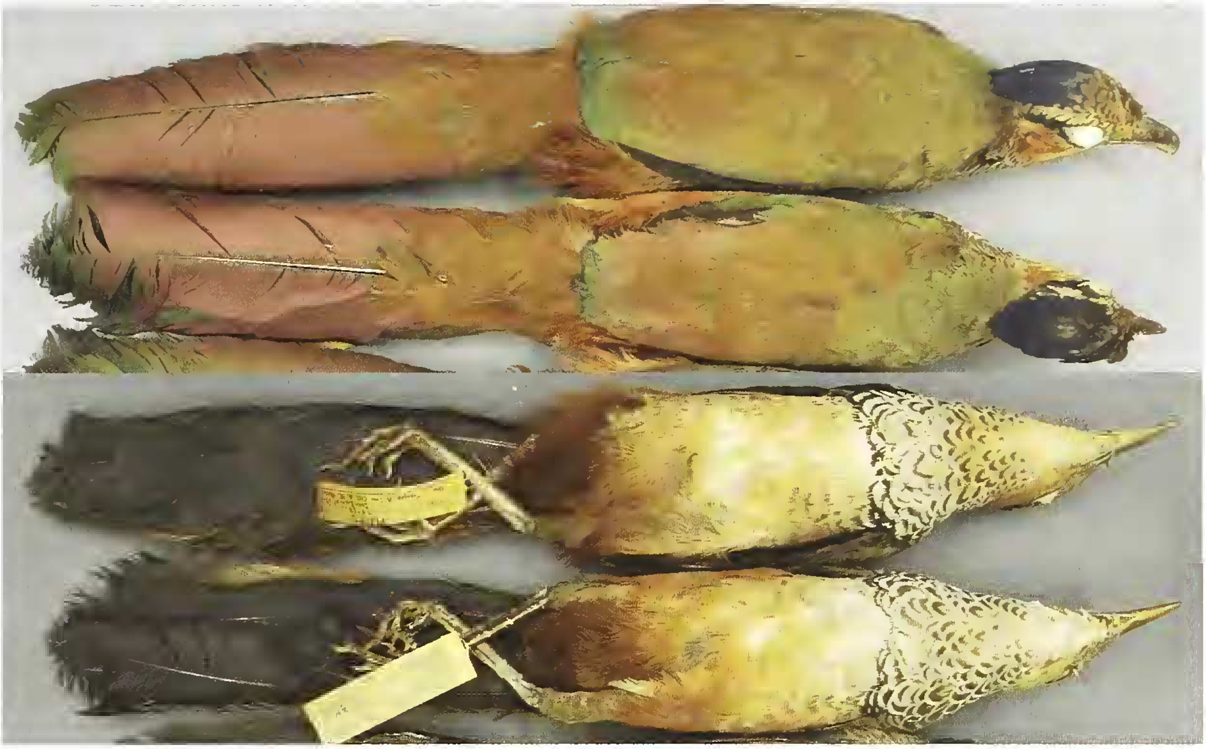

Figure 2. Dorsal and ventral view of *Neomorphus squamiger iungens* (type, MCZ 173564; top in each panel) and *N. s. squamiger* (MCZ 173562) (Marcos A. Raposo)

collected at Colônia do Mojuy, near Santarém, on the east (right) bank of the rio Tapajós, in central Amazonia (Todd 1925). Although Todd (1925) did not provide a comparative diagnosis for *N. squamiger*, his description highlighted several plumage characters that differentiated it from *N. geoffroyi*. Todd (1925) was followed by Pinto (1938, 1964) and Meyer de Schauensee (1966, 1982). Peters (1940) opined that the two taxa would prove to be conspecific, but he continued to treat *N. squamiger* specifically because the ranges of *N. squamiger* and *N. geoffroyi* were so imperfectly known. One year later, Griscom & Greenway (1941) described *N. squamiger iungens* on the basis of a female from Boim, on the west (left) bank of the rio Tapajós (Fig. 2). This taxon was soon considered invalid by Gyldenstolpe (1945) and Pinto (1964).

In recent decades, *N. squamiger* has frequently been treated as a subspecies of *N. geoffroyi* (Haffer 1977, Payne 1997, 2005). Haffer (1977) considered *N. squamiger* part of a clinal group of subspecies in Amazonia, including *N. g. geoffroyi*, *N. g. amazonicus* and *N. g. australis*. However, he acknowledged that this hypothesis would only be confirmed if additional specimens from the upper rio Tapajós drainage, the lower rio Madeira, and the rio Xingu exhibited smooth clinal intergradation with geographically adjacent populations of *N. geoffroyi*. Sibley & Monroe (1990) noted the absence of intergradation between *N. squamiger* and geographically proximate populations of *N. geoffroyi*, but considered *N. squamiger* to be an allospecies of the *N. geoffroyi* superspecies complex. Payne (1997) likewise retained *N. squamiger* as a subspecies of *N. geoffroyi*, but remarked that it might better be treated specifically. Subsequently, Payne (2005) classified *N. squamiger* as a subspecies of *N. geoffroyi*, while observing that specimens across the geographic range of *N. g. geoffroyi*, *N. g. australis* and *N. squamiger* displayed intergradation in plumage characters. However, neither Payne (1997, 2005) nor Sibley & Monroe (1990) were aware of a recently collected specimen of *N. squamiger* from the right bank of the rio Xingu, which represents a significant eastward range extension (Graves & Zusi 1990). The aim of the present study is to address the implications of this specimen for the taxonomic status of *N. squamiger* and to evaluate the validity of *N. s. iungens*.

Methods

We examined 83 specimens, including 17 of *N. squamiger*, 66 of *N. geoffroyi*, and the type specimens of both (Raposo *et al.* 2009; Appendix 1). Analyses focused on plumage pattern and colour, particularly of the ear-coverts and malar regions, and the size and shape of the breast-band. Specimen localities transcribed from museum labels were mapped according to geographical coordinates obtained from ornithological gazetteers (Stephens & Traylor 1983, Paynter & Traylor 1991, Paynter 1992, 1993, 1997). Geographical coordinates for localities in Central America were obtained from Global Gazetteer (2009). The program ArcView 3.2 (ESRI 1999) was used to elaborate the maps.

Results and Discussion

Comparative analysis of specimens revealed that the diagnostic plumage characters of *N. squamiger* are relatively uniform across its geographic range in the Madeira–Tapajós–Xingu–Tocantins interfluvia (Fig. 3). Consistent with Pinto (1964), all specimens of *N. squamiger* examined by us possess a rudimentary breast-band and unmarked cinnamon-buff ear-coverts and malar regions, rather than a well-developed breast-band and barred ear-coverts and malar, which typify the nearest populations of *N. g. amazonicus* (Fig. 4). Of special importance, the recently collected specimen of *N. squamiger* from the right (east) bank of the rio Xingu (USNM 572531; see Appendix 1 for museum acronyms) exhibited no evidence of intergradation with *N. geoffroyi* (Fig. 4). As there are no major rivers between the Xingu and Tocantins, it is probable that *N. squamiger* ranges east as far as the last-named

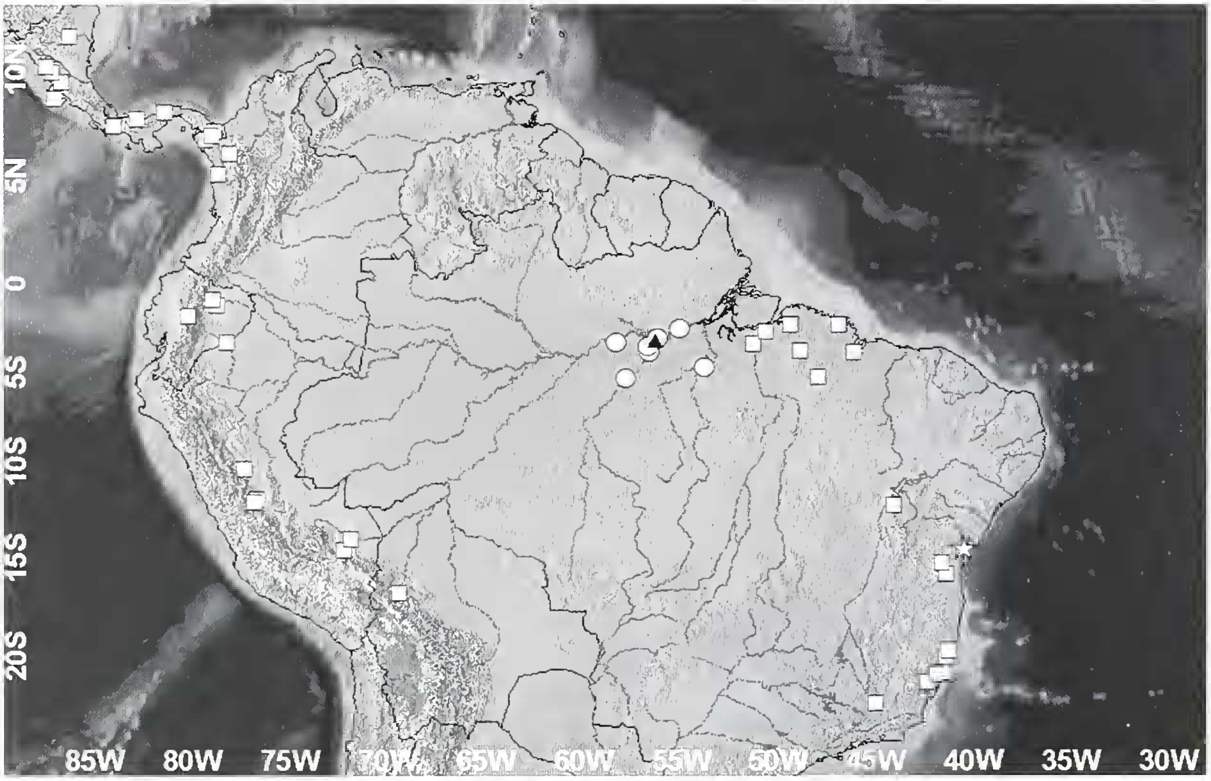

Figure 3. Distribution of specimens of *Neomorphus geoffroyi* (white squares) and *N. squamiger* (white circles) examined in this study. The black triangle and white star represent, respectively, the type localities of *N. squamiger* (Santarém, Pará, Brazil) and *N. geoffroyi* (rio Jaguaribe, Bahia, Brazil).

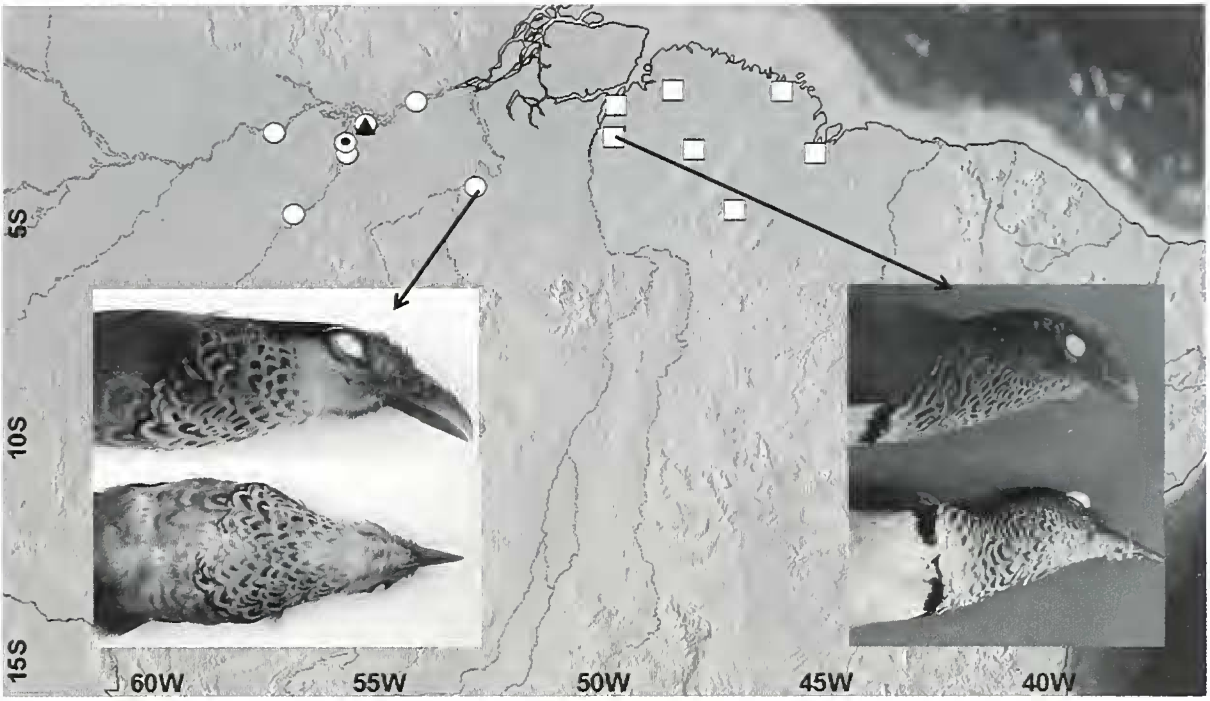

Figure 4. Detailed range of *Neomorphus geoffroyi* specimens from Pará and Maranhão (white squares) and *N. squamiger* (white circles) examined in this study. The photographs depict specimens of *N. geoffroyi* (right, AMNH 430468—Baião, rio Tocantins, Pará: Marcos A. Raposo) and *N. squamiger* (left, USNM 572531—east bank of rio Xingu above the mouth of the rio Iriri, Pará: Gary R. Graves). The black triangle and white circle with black spot represent, respectively, the type localities of *N. s. squamiger* (Santarém, Pará, Brazil) and *N. s. iungens* (Boim, left bank of rio Tapajós, Pará).

river. The westernmost specimens of *N. g. amazonicus* (AMNH 430467, 430468, 430469) were taken at Baião, on the east (right) bank of the rio Tocantins *c*.350 km north-east of the Xingu specimen of *N. squamiger*. These specimens show no evidence of intergradation with *N. squamiger* (Fig. 4).

Griscom & Greenway (1941) proposed that *N. s. iungens* could be distinguished from nominate *N. s. squamiger* in (1) having feathers of the forehead and crown buffy brown tipped dull bluish and with bluish centres, (2) a slightly more bronzy-green mantle, (3) greener and less coppery-red secondaries, (4) ear-coverts much deeper cinnamon-buff, (5) chin and throat uniform rich buff instead of 'soiled' whitish or greyish, (6) dark subterminal area on breast feathers less extensive, and (7) in having a more distinct breast-band. Based on a comparison of specimens of *N. s. iungens* and *N. s. squamiger* housed in the Swedish Museum of Natural History, Gyldenstolpe (1945) concluded that the supposed distinguishing characters were due to age differences and individual variation. Our analysis confirms that of Gyldenstolpe. Forecrown coloration in *N. squamiger* exhibits significant individual variation unassociated with geography (Fig. 5). Mantle colour is even more variable and some specimens from opposite sides of the rio Tapajós are virtually identical (Gyldenstolpe 1945, Pinto 1964). Our analysis of the colour of the ear-coverts, chin and throat also agree with the conclusions of Gyldenstolpe (1945); there are no consistent differences between specimens collected on opposite banks of the Tapajós (Fig. 5). Nor are there any consistent differences in the extent of the dark subterminal portions of the breast feathers in specimens from the left and right banks of the Tapajós (Figs. 5–6). For example, in the type series of *N. s. squamiger*, from Colônia do Mojuy, the dark subterminal parts of the breast feathers in CMNH 74616 (Fig. 6) are less extensive than in the other specimens from this locality (CMNH 74542, 74615, 75075), and far less extensive than in the type of

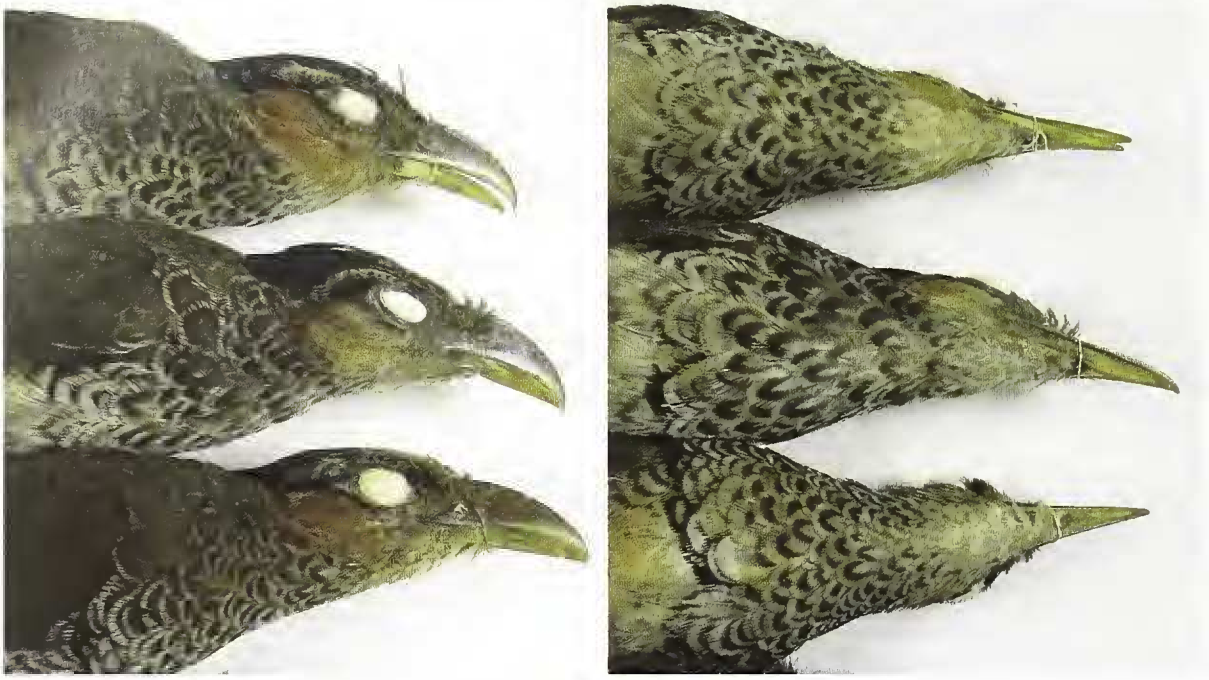

Figure 5. Lateral and ventral views (top to bottom) of *N. s. squamiger* (NRM 570204, Prainha, right bank of rio Tapajós), *N. s. squamiger* (NRM 570205, Caxiricatuba, right bank of rio Tapajós) and *N. s. iungens* (NRM 570206, Patinga, left bank of rio Tapajós) (© Göran Frisk, Swedish Museum of Natural History, Stockholm)

N. s. iungens (Fig. 2). The breast-band is similarly variable in specimens from the left and right banks of the Tapajós (Figs. 2, 5, 6). In conclusion, we concur with Gyldenstolpe (1945) and Pinto (1964) that the supposed diagnostic characters of *N. s. iungens* reflect individual variation. Consequently, *N. s. iungens* Griscom & Greenway 1941, must be treated as a junior synonym of *N. squamiger* Todd, 1925.

On the other hand, *N. squamiger* should be treated as a species restricted to the Madeira–Tapajós–Xingu–Tocantins interfluvia, based on the geographic uniformity of the unmarked cinnamon-buff ear-coverts and malar regions. The extent to which the geographic range of *N. squamiger* approaches some Amazonian populations of *N. geoffroyi* in eastern Pará is unknown. Doubts over the correct identification of some sight records at Alta Floresta, northern Mato Grosso, discussed by Lees *et al.* (2013) are adequately resolved by a photographic record of *N. squamiger* from that locality (www.wikiaves.com.br; WA1203910).

The lumping of *N. squamiger* with *N. geoffroyi* by several authorities (Haffer 1977, Sibley & Monroe 1990, Payne 1997, 2005) reflects a conservative philosophy, in vogue among avian taxonomists in the mid-20th century, which has resulted in substantial under-estimation of species diversity among Amazonian birds. Recent molecular, morphological and behavioural investigations have suggested that dozens of populations currently treated as subspecies should be afforded specific status (e.g., Ribas *et al.* 2006, 2012, Isler *et al.* 2007, Oppenheimer & Silveira 2009). Payne (2005) classified *N. squamiger* as a subspecies of *N. geoffroyi* because the genetic distance in two mitochondrial genes (12S and ND2) observed between one specimen of *N. squamiger* (AMNH 278613) and a specimen of *N. geoffroyi salvini* from Panama was less than that between those specimens and other ground cuckoos. However, we note that the genetic distance between *N. squamiger* and *N. geoffroyi* was greater than that between some other pairs of cuckoos deemed by Payne to be species. Moreover, genetic distance is only one of several indicators of speciation in the Cuculidae

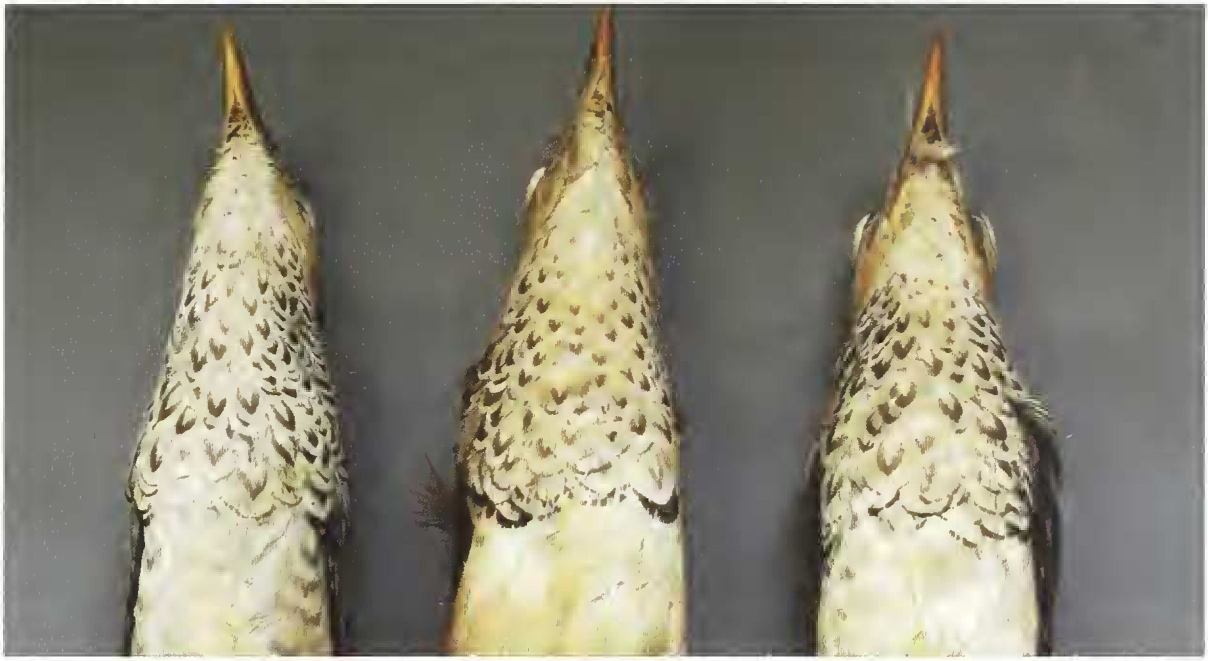

Figure 6. Individual variation in feather pattern and development of breast-band in three specimens of *N. s. squamiger* from Colônia do Mojuy, Pará (left to right: CMNH 75075, 74616 and 74542) (Marcos A. Raposo)

(Payne 1997, 2005). Differences in song and the colour of the facial skin, bill, and the head, neck and breast plumage, may also provide clues to species limits in *Neomorphus*. In this case, the distinctive differences in the facial plumages of *N. squamiger* and *N. geoffroyi*, combined with those in neck and breast plumage provide additional evidence of species-level differences. We anticipate that a more extensive molecular investigation of the *N. geoffroyi–N. squamiger* clade will reveal complex patterns of population differentiation and speciation. Confirmation of the validity of *N. squamiger* emphasises the need to evaluate the conservation status of this poorly known species, as it is threatened by the degradation, fragmentation and loss of habitat as well as hunting in the Amazon basin (BirdLife International 2014).

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Appendix 1: Specimens examined

American Museum of Natural History, New York (AMNH); Carnegie Museum of Natural History, Pittsburgh (CMNH); Field Museum of Natural History, Chicago (FMNH); Museu de Zoologia da Universidade de São Paulo, São Paulo (MZUSP); Museu Nacional, Rio de Janeiro (MN); Museu Paraense Emílio Goeldi, Belém (MPEG); Museum of Comparative Zoology, Cambridge, MA (MCZ); National Museum of Natural History, Smithsonian Institution, Washington DC (USNM); Academy of Natural Sciences, Philadelphia (ANSP) and Swedish Museum of Natural History, Stockholm (NRM).

Neomorphus squamiger: BRAZIL: Amazonas: Parintins, rio Amazonas (02°36′S, 56°44′W), ♂, AMNH 278613. Pará: Colônia do Mojuy, near Santarém (02°26′S, 54°42′W), ♀, CMNH 74542, 74616; ♂, CMNH 74615 (holotype *N. s. squamiger*), 75075. East bank of the rio Xingu above the mouth of the rio Iriri (03°50′S, 52°40′W), ♂, USNM 572531. Tauari, right bank of rio Tapajós (03°05′S, 55°06′W), MCZ 173562; ♂, MCZ 173563. Boim, left bank of rio Tapajós (02°49′S, 55°10′W), ♀, MCZ 173564 (holotype, *N. s. iungens*). Cuçari (01°54′S, 53°33′W), ♀, MPEG 3791. Villa Braga, rio Tapajós (04°25′S, 56°17′W), ♀, MPEG 13715. Prainha, right bank of rio Tapajós, ♀, NRM 570204. Caxiricatuba, right bank of rio Tapajós, ♂, NRM 570205. Patinga, left bank of rio Tapajós, ♂, NRM 570206; ♀, NRM 570207. Piquiatuba, right bank of rio Tapajós (02°24′S, 54°41′W), ♀, MZUSP 17464; ♂, MZUSP 21102. Morro do Pau da letra, left bank of rio Tapajós (02°24′S, 54°41′W), MZUSP 40646.

Neomorphus geoffroyi: NICARAGUA: Peña Blanca, ♂, AMNH 103705, 103706. Matagalpa: río Tuma, ♀, AMNH 103577. Savala, ♂, AMNH 102493. Rivas: San Emilio, Lago Nicaragua, ♀, FMNH 21874. COSTA RICA: Carrillo (09°52′N, 85°30′W), ♀, AMNH 415938. Cerro Santa María (10°81′N, 85°31′W), MCZ 20732. Alajuela: La Bijagua, MCZ 20731. PANAMA: Chiriquí, Obaldía, ♂, MCZ 155254; ♀, MCZ 156093. Darién, Caña, ♂, MCZ 140546. Citaro, río Capé, ♀, AMNH 136495; ♂, AMNH 136494. Tacarcuna, ♀, AMNH 135485. Tapalisa, ♀, AMNH 136496. Panamá: Perme, ♀, MCZ 155253. Barro Colorado (91°10′N, 79°56′W), ♀, AMNH 228920. Veraguas: río Calovébora, ♂, AMNH 246610; ♀, AMNH 246611. COLOMBIA: Antioquia: Alto Bonito (07°05′S, 76°30′W), ♀, AMNH 133204. Chocó: Serranía de Baudó (06°00′S, 77°00′W), ♀, AMNH 123274. ECUADOR: Tungurahua: río Pastaza, ♂, FMNH 101047. Napo: río Suno (00°42′S, 77°08′W), ♂, AMNH 179092. San José Nuevo (00°26′S, 77°20′W), AMNH 199094; ♂, AMNH 179093, 199095. Pastaza: río Bobonaza, Sarayacu, ♂, FMNH 77375. PERU: Cuzco: Quincemil (13°31′S, 71°59′W), ♀, FMNH 208174, 208175. Huánuco: La Divisoria (09°05′S, 75°46′W), ♀, FMNH 187766. Junín: Yurinaqui Alto (10°47′S, 75°13′W), ♂, FMNH 282558. Madre de Dios: río Colorado (12°39′S, 70°20′W), ♀, FMNH 222888. Pasco: Cacazú (10°19′S, 75°05′W), FMNH 296598. BOLIVIA: La Paz: río Mapiri, Guanay (15°25′S, 67°49′W), ♀, ANSP 120763 (holotype of *N. g. australis*). BRAZIL: Bahia: Fazenda Santa Maria, rio Gongogi, ♂, MCZ 169388. Jequié (13°51′S, 40°05′W), ♂, MZUSP 14146. rio Jaguaribe (13°06′S, 38°56′W), AMNH 6086 (lectotype of *N. g. geoffroyi sensu* Raposo *et al.* 2009). Espírito Santo: ♀, MZUSP 6380; ♂, MZUSP 6379. Fazenda Boa Lembrança, rio Itaúnas, Conceição da Barra (18°35′S, 39°45′W), ♂, MN 44335. Lagoa Juparanã, Fazenda Santa Anna (19°35′S, 40°18′W), ♀, MN 4057. Norte, ♂, MN 26147. Patrimônio da Palha, rio São José, ♀, MN 39535; rio Doce, ♂, MZUSP 6723. São Mateus (18°44′S, 39°51′W), ♂, MN 12096. Mato Grosso: rio Manuel Corrêa, upper rio São Miguel, MN 4273. Goiás: Espírito Santo do Peixe, rio Tocantins, MN 4098. Maranhão: Buriticupú (04°20′S, 46°24′W), ♀, MPEG 37332. Rio Mearim, Pedreiras (03°04′S, 44°35′W), ♂, MN 44336. Turiaçu (01°41′S, 45°21′W), ♀, FMNH 64074, 64075, MN 32348; ♂, FMNH 64073, MN 4272. Minas Gerais: rio Doce, ♂, MZUSP 24784, 24785. Rio Matipó (10°53′S, 42°33′W), MZUSP 10364, 18365. Rio São José, upper rio Doce, ♂, MN 26361. Pará: Baião, rio Tocantins (02°41′S, 49°41′W), ♀, AMNH 430469; ♂, AMNH 430467, 430468. Capim (01°40′S, 47°47′W), ♀, MZUSP 43959, 43960. Paragominas (03°00′S, 43°18′W), ♂, MPEG 28441. Rio Capim, Ressaca (01°40′S, 47°47′W), ♀, MPEG 1391.